Engineering Proposal: Subway Air and Ventilation Enhancement (SAVE)

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Program Overview and Qualifications

The proposed program, Subway Air and Ventilation Enhancement (SAVE), is to upgrade or replace older ventilation systems within the subway stations of New York City in order to decrease particulate matter (PM) concentrations. Additionally, low-cost sensors will be used to gather real-time PM concentration data, which can range in cost from hundreds to a couple thousands (Berryman, 2024). Particulate matter poses a great danger, especially in the confined space of a subway station (Martins et al., 2015). The team has an extensive background in machinery and materials as they developed an electrostatic precipitator (ESP) type air conditioner to reduce fine PM in subways (Lee et al., 2022). By adding newly developed air conditioners and ventilation systems in the subways, the air quality can be improved while also increasing energy efficiency. Accounting for the cost of measuring the PM concentrations and implementing new ventilation and air conditioning systems to several subway stations, the projected budget is estimated to be $550,000.

Context, Costs, and Scope

Millions of people take public transportation every day, and most public transportation was built underground or indoors. There are many health risks when large machinery is contained into a space without the proper ventilation. This includes respiratory, cardiovascular, metabolic, and neurological disorders (A Comprehensive Analysis of the Air Quality…). The World Health Organization claims that 4.3 million deaths are caused by indoor air contaminants worldwide (Revitalizing Subterranean Spaces). On top of the health risks, indoor transportation generates a lot of heat, especially with large amounts of people. Preventative cooling and ventilation of these systems can be costly and energy consumption heavy. Major cities' subway systems are over one hundred years old and were not designed for the current rate at which they are used, and are in no way inclined for modern heating, ventilation, and air conditioning (HVAC) systems.

The most dangerous of particulate matter (PM) that can be found in indoor transit systems are microparticles of toxic metallic content being constantly inhaled by daily commuters. They are generated from braking systems and metal rails grinding against trains. The purpose of this project is to take a closer look at how much PM is being produced and how to reduce it in train stations in the most efficient and cost effective way.

About SAVE

The program is called SAVE, standing for Subway Air and Ventilation Enhancement. The goal of this program is to decrease PM concentrations within subway stations across New York City. SAVE is a feasible and scalable plan, supported by precedent in global urban transit systems. Seoul’s metro system and Madrid’s Barcelona Metro AI ventilation platform have both

demonstrated the viability of smart ventilation and real time air quality monitoring (Thermo Fisher Scientific, 2023; Sener, 2023). NYC's subway stations already have HVAC infrastructure, allowing these upgrades to be implemented with minimal disruption (MTA, 2021). Feasibility will be confirmed through initial testing in 2 or 3 busy stations.

Implementing SAVE will:

- Reduce commuter exposure to PM, improving respiratory and cardiovascular health
- Minimize heat buildup in subway stations
- Increase energy efficiency with modern HVAC technologies
- Extend the operational life of infrastructure by reducing corrosion and mechanical wear
- Promote public confidence in the safety and cleanliness of public transit

If the program is not utilized, millions of daily commuters will continue to be exposed to harmful PM levels, contributing to long term health issues and increasing healthcare costs. Not implementing it will also result in missed opportunities to modernize outdated infrastructure and reduce energy inefficiencies across the MTA system.

SAVE will be implemented by upgrading or replacing old ventilation and air conditioning systems in select stations. At the start, a research phase will be done in order to measure and analyze the PM concentrations across the subway stations. This will include using low-cost sensors such as PurpleAir sensors for any stations without available data on their PM concentrations. The stations with the highest PM concentrations will be identified and focused on in order to increase the efficiency of the program and save resources. Then, SAVE will implement the upgraded ventilation or electrostatic precipitator (ESP) air conditioning system to these stations. Some of the resources needed are low-cost sensors such as PurpleAir sensors to

measure the amount of PM, ESP air conditioning systems, modern ventilation equipment, a research team, an engineering team, an installation team, and a budget of around $550,000.

Some potential obstacles are implementing this program without disrupting the train schedules in the subway stations. However, this will be mitigated by communicating with the transit authorities and implementing the program while working around busy hours. Another potential obstacle could be with subway stations that have older infrastructure which haven't been maintained for a long period of time. Although this could cause difficulties with installing new ventilation and air conditioning systems, the problem will be overcome by having a specialized team of engineers to assess the infrastructure of the subway station, which will be part of the research phase. Overall, the SAVE program is expected to take between 9-13 months to fully implement. This time period will consist of 2-3 months for research and inspections, followed by 2 months for planning, gathering the equipment, and coordinating the installations. Then, 4-6 months will be needed for installing the new ventilation and air conditioning systems while working around peak hours. Finally, the last 1-2 months will be used for testing and adjusting the new systems to address any issues.

Budgeting breakdown

Phase 1: Deep Dive Assessment & Planning	$90,000
Phase 2: Pilot System Implementation (2-3 Stations)	$285,000
Phase 3: Ongoing Monitoring & Optimization	$50,000
Contingency & Risk Mitigation	$75,000

Project Management & Administration	$50,000
Total Estimated Budget	Estimated at around $550,000

What does each phase cover?

Phase 1 isn't just taking a quick look at the subway station and installing low cost sensors, it's about laying a solid foundation for the project to function efficiently. In phase 1, a detailed survey of the site will be made, where engineers will take a look at pre-existing ventilation infrastructure, station layouts, airflow patterns. The engineers will also install sensors to track patterns and analyze trends that happen throughout different times of the day, this will provide the engineers with data so they can start to make drafts and blueprints.

Phase 2. During this phase, we plan to handpick 2 to 3 stations and wire them with electrostatic precipitator (ESP) technology, modern HVAC equipment and ventilation. This phase serves as a test bed for the previous phase and allows engineers to get real world testing.

Phase 3. This is a combination of the previous 2 phases, however in this phase engineers can fine tune and tweak the ventilation and sensor network in order to achieve better airflow results. We can think of this phase as the 'learning and adapting' phase where we can improve on all our previous design flaws.

Contingency & Risk Mitigation. This part is a safety net that covers problems that may arise in the future, such as discovery of hazardous materials during installation, unexpected geological/structural complexities which can even require more engineering or construction work. It also covers delays in equipment delivery leading to increased labor costs.

Project Management & Administration. Given the importance of this project, effective management is required. A dedicated team will be required to oversee operations, making sure that all tasks are well organized and completed within established deadlines.

While the total estimated budget is around **$550,000**, actual costs may be higher. The MTA has a track record of overspending on infrastructure projects. For example, they once spent $700,000 at a single station solely to install and test anti fare evasion turnstiles.

A Call to Action

The SAVE program provides a realistic and well supported plan to address the urgent issue of air quality in New York City's subways. This initiative can deliver measurable improvements in commuter health, system sustainability, and public trust by deploying low cost sensors and proven air filtration technologies. Our targeted approach ensures both feasibility and effectiveness while keeping costs within a reasonable range. We urge decision makers and stakeholders to prioritize this initiative, as failure to act will only deepen the ongoing health crisis in underground transit spaces. The longer that this is put off, the worse the problem will become, which is why action must be taken immediately in order to start seeing results.

References

Berryman, K. (2024, October 3). *How is particulate matter (PM) measured?*. PurpleAir. https://www2.purpleair.com/blogs/blog-home/how-is-pm-measured#:~:text=One%20of%20the%20more%20commonly,particulate%20matter%20in%20the%20air

Lee, H., Sung, J.-H., Kim, M., Kim, Y.-S., Lee, Y., Kim, Y.-J., Han, B., & Kim, H.-J. (2022, March 22). *Development of Electrostatic-Precipitator-Type Air Conditioner for Reduction of Fine Particulate Matter in Subway*. IEEE Xplore. https://ieeexplore-ieee-org.ccny-proxy1.libr.ccny.cuny.edu/document/9739999

Martins, V., Moreno, T., Minguillón, M. C., Amato, F., de Miguel, E., Capdevila, M., & Querol, X. (2015, January 21). *Exposure to airborne particulate matter in the subway system*. Science Direct. https://www.sciencedirect.com/science/article/pii/S004896971401715X?via%3Dihub

MTA. (2021). *MTA RFI on Cooling Technologies for Subway Platforms*. https://www.mta.info/press-release/mta-releases-request-information-cooling-technologies-new-york-city-subway-platforms

Sener. (2023). *Barcelona Metro AI Ventilation Platform*. https://www.group.sener/en/noticias/the-barcelona-metro-network-will-feature-intelligently-controlled-ventilation-thanks-to-respira-the-new-ai-platform-developed-by-sener

Thermo Fisher Scientific. (2023, May 3). *How Seoul Metro Improves Indoor Air Quality in Subway Stations*. https://www.thermofisher.com/blog/identifying-threats/how-seoul-metro-improves-indoor-air-quality-in-subway-stations